The Long-Term Health Plan and Disability Cost Benefit of Obstructive Sleep Apnea Treatment in a Commercial Motor Vehicle Driver Population

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Objective: To assess the impact on health plan and disability costs associated with continuous positive airway pressure or bi-level positive airway pressure treatment of obstructive sleep apnea in a commercial motor vehicle driver population. **Methods:** A retrospective, pre/post claims-based comparison analysis was performed. Health plan and disability costs, in addition to disability claimant rates and missed workdays were compared for the 12 months before treatment to the 24 months after treatment. **Results:** Health plan costs were significantly lower in both the first and second years after treatment. Short-term disability metrics also exhibited favorable results, with approximately half as many using the benefit, lower costs, and fewer missed workdays in the postperiod. **Conclusions:** Effective treatment of obstructive sleep apnea in drivers is associated with lower health care and disability costs and fewer missed workdays.

In response to the proposed regulation prepared for the Medical Review Board (MRB) of the US Department of Transportation's Federal Motor Carrier Safety Administration and increasing literature on sleep disorders and driver safety, this analysis is designed to assess the long-term financial impact of treatment of obstructive sleep apnea (OSA) in a commercial motor vehicle (CMV) driver population. In January 2008, the MRB reviewed a proposal that suggested all drivers with a body mass index ≥33 (or 30 as proposed by MRB member Dr Allan Pack) be required to participate in OSA testing (and treatment, if applicable) to maintain licensing.[1] As such, this analysis estimates the related cost implications of treatment of employees afflicted with OSA.

By definition, OSA is a medical condition characterized by repetitive episodes of airflow cessation during sleep, often because of collapse of the upper airway. OSA has a variety of adverse consequences, the most common of which are daytime sleepiness that leads to a tendency to fall asleep while driving.[2–4]

The accepted standard to measure the presence and severity of OSA is the apnea-hypopnea index and is defined as the number of apneas and hypopneas per hour of sleep. Although measurement techniques to help and understand the prevalence of OSA have varied, a published study by Pack et al[5] estimated the percent of commercial drivers in the United States suffering from at least mild OSA (apnea-hypopnea index ≥5) to be roughly 28%. OSA affects men more often than women and at least 85% of those with clinically significant OSA remain undiagnosed.[6] Untreated OSA, according to the US Department of Transportation's Task Force on Pulmonary Disorders and Commercial Drivers,[7] is an important preventable cause of motor vehicle accidents. Studies have suggested an increased risk for accidents for those with OSA, and estimates have ranged from an astounding 200% to 700%.[8–12]

An overnight study in a sleep laboratory, called a polysomnogram, or an at-home testing device are two of the common testing procedures used to clinically diagnose OSA. Once diagnosed, two devices have been confirmed to be safe and effective at treating OSA: continuous positive airway pressure (CPAP) treatment and bi-level positive airway pressure (BiPAP) treatment.[13,14] Both machines apply pressure inside the throat to keep it from collapsing; however, unlike the continuous pressure delivered from the CPAP machine, the BiPAP does so at variable levels.

Numerous studies exist in the literature suggesting the effectiveness of CPAP/BiPAP treatment in reducing the number of auto-related accidents for drivers.[15–19] As such, this study expands further into the economic implications of treating diagnosed OSA by examining the associated health plan and disability cost impact in a population of CMV drivers.

METHODS

Data

A retrospective study was performed using a comprehensive database containing medical claims, pharmacy claims, disability claims, demographic, employment, and compensation information from the nation's largest waste removal company, Waste Management. The subset of data used for this analysis was their population of CMV operators in the United States.

Population

This analysis focuses on employees who were diagnosed with OSA and received CPAP or BiPAP treatment. A list of durable medical equipment codes for the CPAP or BiPAP machine was used to identify the population. The following procedure codes identified treatment: E0601, W9415, Z0613, and 94,660 (CPAP) and E0470, E0471, and E0472 (BiPAP). The study includes individuals with CPAP or BiPAP treatment between January 1, 2004, and March 31, 2007, using their earliest date of treatment as their index date. Individuals must have been employed and enrolled in medical, pharmacy, and disability benefit plans with available data for the entire 12-month period preceding the index date and the 24-month period after the index date. For this article, the 12-month preindex date period will be referred to as the preperiod, the 12-month postindex date period will be referred to as the first postperiod, and the second 12-month postindex date period will be referred to as the second postperiod. The cost of the CPAP/BiPAP and other related treatment costs are included in the first postperiod.

A nontreated OSA control group using the CMV driver population was constructed using the diagnosis codes from January 1, 2004, through March 31, 2007. The following OSA International Classification of Diseases, 9th revision diagnosis codes were used to identify this group: 327.2x, 780.51, 780.53, and 780.57. This group did not have evidence of CPAP/BiPAP treatment or treat-

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ment maintenance (including CPAP/BiPAP device accessories) in all of the available claims data that spans from January 1, 2001, through June 30, 2009. The day after the first diagnosis date of OSA was used as the index date in an effort to be consistent with the study group and include costs for the sleep apnea test in the preperiod when this test occurred on the same date as the first diagnosis. As in the study group, individuals must have been employed and enrolled in medical, pharmacy, and disability benefit plans with available data for the entire 12-month period preceding the index date and the 24-month period after the index date.

Medical and drug claims incurred through March 31, 2009, with health plan payments through June 30, 2009, were used. All cost metrics are adjusted for inflation to June 2009 dollars. It is worth noting that an individual in the study group with >$300,000 in health plan cost in the preperiod was excluded based on an outlier analysis.

Analytic Comparisons

1. A demographic comparison was made between the study group and the control group.
2. A cost savings analysis compared total health plan costs (medical services and prescription drug costs) and short-term disability costs in the preperiod to the first and second postperiods. Short-term disability costs represent income replacement costs paid to workers when they are unable to be on the job. The short-term disability claimant rate and average lost workdays are also compared between the preperiod and the first and second postperiods. These comparisons were made for both the study and the control groups.
3. A study and control group comorbidity analysis examined the cost of services within various coexisting condition categories. These conditions were grouped according to the 17 Agency for Healthcare Research and Quality Major Diagnostic Categories (MDCs) that group International Classification of Diseases, 9th revision diagnosis codes into major organ-, disease-, and therapeutic-specific categories.[20] The average annual medical cost paid by the health plan was calculated and compared for each of the MDCs with a breakdown of other conditions to include sleep apnea and other major cost drivers.

Statistical Analysis

Data analysis was generated by the SAS software platform version 9.1.3. By using the study group and comparison group of drivers in analytic comparison 1, two-sample *t* tests were used to assess differences in age and tenure, a χ^2 test was used to address differences in union status, and Fishers exact test was used to assess differences in gender. To address analytic comparison 2, paired *t* tests were used to test the significance of the difference in average total health plan costs, average short-term disability costs and lost workdays from the preperiod to first and second postperiods. Demographic differences across time periods are controlled for by using a paired test where each individual in the preperiod is compared with himself in the postperiod. To test the significance of the difference in short-term disability claimant rates from the preperiod to the first and second postperiods McNemar's test was used. To identify the MDCs with health plan cost savings, paired *t* tests were used to test the significance of the difference in average health plan costs by MDC for the preperiod versus the first and second postperiods (analytic comparison 3). A significance level of 5% was used for all tests.

RESULTS

Analytic Comparison 1

The study group consisted of 156 drivers identified using the previously mentioned procedure codes for having a CPAP or BiPAP treatment. The control group consisted of 92 drivers identified using the previously mentioned diagnosis codes for having OSA, but no claims based evidence of CPAP or BiPAP treatment. The study group and control groups had similar demographic profiles with no significant differences (Table 1).

Analytic Comparison 2

By using the 1 year before treatment as a baseline for the study group, the first postperiod health plan costs decreased by an average of $2727 ($P = 0.002$). Costs were even lower in the second postperiod resulting in an additional $3086 ($P = 0.008$) in health

TABLE 1. Demographic Comparison

	Study Group ($N = 156$)		Control Group ($N = 92$)		
Metric	**Mean**	**Standard Error**	**Mean**	**Standard Error**	***P****
Age (yr)	44.7	0.7	44.4	0.9	0.758
Male	99.4%	0.6%	95.7%	2.1%	0.065
Tenure	11.6	0.6	11.1	0.8	0.652
Union	14.1%	2.8%	9.8%	3.1%	0.320

**P*-values result from the two sample *t* test (for age and tenure), the χ^2 test (for union status), and Fisher exact test (for gender) between the study group and the control group.

TABLE 2. Health Plan and STD Cost Comparison

		Health Plan Cost		STD Cost		Total Cost	
Time Period	**Statistic**	**Study**	**Control**	**Study**	**Control**	**Study**	**Control**
Pre	Mean	$7439	$5486	$467	$278	$7906	$5764
	Standard error	$878	$1426	$112	$102	$934	$1487
First Post	Mean (*P**)	$4712 (0.002)	$4789 (0.665)	$99 (0.002)	$199 (0.667)	$4811 (0.001)	$4989 (0.652)
	Standard error	$627	$903	$40	$147	$654	$1002
	Percent change	−36.7	−12.7	−78.8	−28.4	−39.1	−13.4
Second Post	Mean (*P**)	$4353 (0.008)	$4969 (0.774)	$307 (0.301)	$364 (0.682)	$4660 (0.008)	$5333 (0.823)
	Standard error	$979	$1251	$140	$182	$1036	$1380
	Percent change	−41.5	−9.4	−34.3	30.9	−41.1	−7.5
Total 2-yr savings		$5813	$1214	$528	($7)	$6341	$1206

**P*-values result from the paired *t* test between the preperiod and the corresponding postperiod.

TABLE 3. Short-Term Disability Metrics Comparison

		Short-Term Disability Days Absent		Percent of Employees With a Short-Term Disability Leave	
Time Period	**Statistic**	**Study**	**Control**	**Study**	**Control**
Pre	Mean	6.1	3.2	14.7%	12.0%
	Standard error	1.4	1.1	2.8%	3.4%
First Post	Mean (*P**)	1.7 (0.004)	2.0 (0.514)	7.1% (0.036)	5.4% (0.180)
	Standard error	0.7	1.4	2.1%	2.4%
	Percent change	−71.7	−38.0	−52.2	−54.5
Second Post	Mean (*P**)	3.6 (0.201)	4.2 (0.648)	7.7% (0.052)	10.9% (0.808)
	Standard error	1.6	2.0	2.1%	3.3%
	Percent change	−40.6	33.6	−47.8	−9.1

**P*-values result from the paired *t* test for the difference in lost days and McNemar's test for the difference in claimant percent between the preperiod and the corresponding postperiod.

TABLE 4. Study Group MDC Cost Comparison

	Study Group (*N* = 156)			
Major Diagnostic Category	**Pre**	**First Post (*P**)**	**Second Post (*P**)**	**2-yr Cost Savings**
Other conditions	$2707	$1570 (<0.0001)	$425 (<0.0001)	$3419
Sleep apnea	$2105	$1289 (<0.0001)	$276 (<0.0001)	$2644
Sleep disturbances	$139	$64 (0.119)	$15 (0.001)	$200
Abdominal and pelvic pain	$257	$134 (0.558)	$53 (0.318)	$327
Routine examinations	$22	$15 (0.340)	$23 (0.859)	$5
Other	$184	$68 (0.016)	$57 (0.010)	$243
Respiratory system	$973	$149 (0.138)	$213 (0.163)	$1584
Circulatory system	$1055	$1141 (0.839)	$388 (0.026)	$581
Skin and subcutaneous tissue	$177	$10 (0.316)	$31 (0.383)	$312
Musculoskeletal and connective tissue	$453	$202 (0.240)	$449 (0.989)	$255
Injury and poisoning	$366	$258 (0.667)	$222 (0.516)	$253
Neoplasms	$334	$30 (0.246)	$585 (0.637)	$52
Endocrine and metabolic diseases	$184	$231 (0.761)	$107 (0.309)	$31
Maternity	$4	$0 (0.201)	$3 (0.769)	$6
Infectious and parasitic diseases	$9	$7 (0.616)	$6 (0.362)	$6
Congenital anomalies	$3	$1 (0.497)	$1 (0.551)	$4
Perinatal period	$1	$1 (0.699)	$0 (0.319)	$2
Blood and blood forming organs	$10	$4 (0.235)	$17 (0.428)	$0
Mental disorders	$10	$8 (0.634)	$19 (0.209)	−$7
Digestive system	$247	$226 (0.889)	$311 (0.722)	−$43
Genitourinary system	$97	$192 (0.380)	$114 (0.867)	−$113
Nervous system and sense organs	$218	$45 (0.009)	$765 (0.411)	−$374

**P*-values result from the paired *t* test between the preperiod and the corresponding postperiod.

plan cost savings when compared with the baseline. Average short-term disability costs also decreased in both the first post and second postperiods, yielding a total 2-year savings of $528. The control group exhibited insignificant differences from the preperiod to both postperiods for all cost metrics (Table 2).

Lost workdays resulting from short-term disability episodes in the treated cohort were significantly lower in the first postperiod (4.4 fewer days, $P = 0.004$). The second postperiod had 2.5 fewer days, though not statistically significant when compared with the preperiod. There were three outliers in the second postperiod with non–OSA-related claims, two of which had claims progressing to long-term disability (>180 days). The percent of drivers with at least one short-term disability claim was reduced considerably as well (Table 3). For the control group, lost workdays and the percent of drivers with a short-term disability claim changed insignificantly from the preperiod to both of the postperiods.

Analytic Comparison 3

To determine the distribution of the cost savings for the study group, health plan costs were stratified by MDC for each of the time periods. Cost savings was greatest in the other conditions category (first postperiod: $1137, $P < 0.0001$; second postperiod: $2282, $P < 0.0001$) with the greatest cost savings in sleep apnea-related costs. Circulatory system cost savings were significant in the second postperiod ($667, $P = 0.026$), and nervous system cost savings were significant in the first postperiod ($173, $P = 0.009$;

TABLE 5. Control Group MDC Cost Comparison

	Control Group ($N = 92$)			
Major Diagnostic Category	**Pre**	**First Post (P*)**	**Second Post (P*)**	**2-yr Cost Savings**
Circulatory system	$2467	$1565 (0.531)	$1059 (0.311)	$2311
Other conditions/screenings/exams	$784	$756 (0.860)	$167 (<0.0001)	$645
Sleep apnea	$530	$543 (0.916)	$31 (<0.0001)	$485
Other	$167	$102 (0.317)	$68 (0.125)	$164
Routine examinations	$27	$22 (0.608)	$16 (0.082)	$16
Sleep disturbances	$40	$66 (0.468)	$2 (0.059)	$13
Abdominal and pelvic pain	$20	$23 (0.896)	$50 (0.282)	−$32
Nervous system and sense organs	$249	$126 (0.245)	$95 (0.174)	$276
Endocrine and metabolic diseases	$169	$146 (0.863)	$90 (0.478)	$102
Skin and subcutaneous tissue	$59	$5 (0.059)	$34 (0.449)	$80
Infectious and parasitic diseases	$23	$9 (0.386)	$8 (0.367)	$29
Blood and blood forming organs	$4	$1 (0.384)	$2 (0.704)	$4
Perinatal period	$1	$0 (0.320)	$0 (0.320)	$1
Maternity	$9	$9 (0.968)	$18 (0.549)	−$10
Congenital anomalies	$26	$63 (0.551)	$1 (0.326)	−$13
Digestive system	$288	$136 (0.336)	$492 (0.585)	−$51
Mental disorders	$7	$8 (0.992)	$94 (0.298)	−$86
Genitourinary system	$54	$180 (0.352)	$77 (0.642)	−$150
Neoplasms	$48	$160 (0.116)	$88 (0.435)	−$151
Respiratory system	$254	$492 (0.185)	$169 (0.302)	−$152
Injury and poisoning	$145	$27 (0.082)	$458 (0.425)	−$195
Musculoskeletal and connective tissue	$166	$161 (0.940)	$1030 (0.144)	−$859

*P-values result from the paired t test between the preperiod and the corresponding postperiod.

Table 4). The control group had significant cost savings in the second postperiod in the sleep apnea category ($499, $P < 0.0001$) that led to significance in the cost savings for the other conditions category in the second postperiod ($617, $P < 0.0001$; Table 5).

DISCUSSION

Limitations

Although the 1 year prior and 2 years posttreatment benefit enrollment criteria is desirable for assessing long-term cost effectiveness of the treatment devices, the size of the study group is reduced as a result. Significant effort was made to ensure that the control group was as comparable as possible to the study group; however, average total costs were still lower for the control group in the preperiod. A side-by-side comparison of the comorbidity analyses (Tables 4 and 5) revealed that the study group had higher sleep apnea-related costs in the preperiod. This difference is likely attributable to higher average sleep apnea diagnostic fees, a higher rate of tests given in the hospital (as opposed to at a sleep center or at-home), and more severe cases of sleep apnea in the study group. This difference in preperiod total cost was not statistically significant ($P = 0.245$). Although initial results display favorable outcomes, a follow-up analysis with even more longitudinal data may be able to confirm that the cost differences seen in this study persist into future years.

CONCLUSION

Drivers who were treated for OSA with either a CPAP or BiPAP device exhibited lower total health plan costs, fewer missed workdays because of short-term disability, and a lower rate of short-term disability claims during the 24 months after the initiation of the treatment, resulting in >$6000 in total health plan and disability cost savings per treated driver. The control group of drivers with OSA who were not treated for their condition did not experience any significant changes in health plan cost, short-term disability claimant rates or lost workdays in the postperiods. In contrast, the remainder of the driver workforce ($N = 7303$) without evidence of OSA experienced a significant increase in average total cost over the same time period when compared with baseline (pre: $1923; post 1: $2170 [$P = 0.013$]; post 2: $2573 [$P < 0.0001$]). This group had the same eligibility criteria as the study group and used an average index date of the study group. Comparing total cost in the preperiod to the second postperiod, the study group experienced a 41% decrease, the control group remained constant with an 8% decrease, and the rest of drivers without OSA increased on average 34% in the 2 years. Addressing OSA in the workplace offers the possibility of early identification and intervention for a chronic disease that is associated with increased health benefit utilization. Providing treatment for those identified with OSA may significantly reduce health care costs and disability rates.

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